BIOFOR™ UPFLOW BIOLOGICAL FILTER
OPERATION INSTRUCTIONS

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I. GENERAL

A. Introduction

The Biological Aerated Filter Pilot Plant for Carbon Oxidation, Nitrification or Denitrification consists mainly of a Biofor™ filter column which can have either 3 or 4 m of filtering media and variable air/water flows. The filter column is mounted on a skid equipped with an automatic cleaning screen, a raw water feed pump, one backwash pump, an air scour compressor, and, in some cases, a cleaning pump and process air compressor. The cross-sectional area of the Biofor C column is 3.14 ft^2 while the Biofor N Pilot unit has a cross-sectional area of 1.77 ft^2. In both cases, influent "raw" water must be pumped to the screen.

The Biofor™ filter works in an upflow fashion from bottom to top. Backwash is performed co-currently to the flow with an air and treated water combination.

There is one fiberglass storage tank per pilot unit that receives filtered water from each respective column. This water is then used for backwashing the filter.

All electrical appurtenances are tied to a control panel (required electrical input is 50A, 460V/3Ph/60Hz) and PLC which allows a fully automated process.

The influent screen is designed for fully automatic operation and can be cleaned on a timed basis.

The maximum raw water pumping capacity to the filter is 11.4 m^3/hr (50 USGPM).

When the backwash cycle is initiated, the raw water flow is interrupted. All valves are automatically operated.

The raw water is introduced through the bottom section of the Biofor™ column. It flows through stemmed nozzles evenly spread out over the false floor and runs through the Biolite™ (granular biological support media) from bottom to top.

The water is purified and filtered through the media, escapes at the weir, and is collected in a retention tank. During Backwash the filtered water is used in combination with air to clean the filter.

The backwash is performed using a backwash pump and an air compressor for air scour. The backwash cycle is executed automatically based on head loss or time, however it can also be initiated manually. A differential pressure sensor records the head loss in the filter.

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The backwash water from the screen, the filtered water, and the backwash rinse water is directed to a 6" waste pipe. The pipe must be connected to a general plant drain or sewer.

B. Description

Biofor™ Submerged Biological Carbonaceous Oxidation with Nitrification Filter

The nitrification filter is a wastewater treatment system designed to treat secondary effluent for:

(1) Removal of both carbonaceous and ammoniacal pollution

(2) Removal of suspended solids from the waste stream

The Biofor™ Process

The Biofor™ process involves two simultaneous steps:

(1) The biodegradation of soluble organic matter by the attached growth biomass

(2) The retention of suspended solids and insoluble organic pollution by simple filtration

II. OPERATIONAL THEORIES

A. Principles of Operation

The operating rates of flow in a Biofor™ vary. Abnormally low flow rates can promote clogging deep down into the filter medium, resulting in disruption of proper operation of the filter. Obviously, clogging makes it more difficult to fully wash the filter. Low flows can also cause channeling of the influent water through the filter. It is highly important for treatment plants that are run seasonally or in low-flow conditions to consider how they wish to approach low-flow conditions.

Whenever the number of filters in service is less than the total number of filters, it is advisable to regularly alternate the filters that are in operation by manually bypassing the respective filter. This approach will make it possible to return all filters to service immediately whenever full-load operation resumes.

In addition, it is preferable to have a constant flow rate of water through the filters (even if it is low) instead of periods of stop-and-go flow throughout the day. If the latter is likely to occur, it is advisable to closely monitor filter operation. This includes, if possible, providing for recirculating the water through the filters if treatment plant output is too low.

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B. Operating Characteristics

The maximum and minimum recommended process operating characteristics are listed in the following table.

PROCESS➔➔➔ PARAMETERS↓↓↓	CARBONACEOUS POLLUTION REMOVAL	NITRIFICATION	DENITRIFICATION
RAW WATER M/h (USGPM/ft^2)			
MINIMUM	4 (1.64)	4 (1.64)	---
MAXIMUM	20 (8.20)	20 (8.20)	30 (12.26)
PROCESS AIR M/h (SCFM)			
MINIMUM	4 (0.75)	4 (0.75)	---
MAXIMUM	15-20 (2.78-3.70)	35 (6.50)	---
LOADINGS Kg/m^3/day			
(MAXIMUM)			
COD	15	8	---
SUS-SOLIDS	5	3	---
T-BOD_5	6	3	---
N-NH_4	---	1.6	---
NO_3-N	---	---	4
FILTER RUN Hours			
MAXIMUM	48	48	24
HEAD LOSS (per meter of media) height m WC (in WC)			
(MAXIMUM)	0.4 (16)	0.4 (16)	---

The capacity to stock suspended solids and biomass increases with the increased volume of media. With the increased volume of Biolite™, the backwash cycles are less frequent and the volume of water required to perform backwash cycles will be relative to the raw water flow rate and loading; the higher the flow rate, the shorter the interval between the cycles.

The pilot is equipped with a filtered water tank that is normally full and overflows to the 6" waste pipe. The volume of filtered water that is required for one backwash is approximately 10 m^3/m^2. The tank is equipped with a drain at the bottom and a connection for the backwash pump.

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The pilot Biofor™ column has two sections:

a) The bottom section (3' high) is welded to the skid floor and has a raw water inlet, backwash water inlet, air scour inlet, high-pressure port connection, air cushion relief, and a drain. This section is flanged and supports the false floor equipped with equally spaced stemmed nozzles through which water and air travel.

b) The top section is flanged at the bottom. A cone encompasses the top of the column to prevent media loss during backwash. The lower end of the Nitrification column is equipped with Oxazur™ diffusers (density: 48/m^2). Constant air flow is maintained during the filtration cycle. An automated bypass valve used in conjunction with a Flowmeter installed on the process air line maintains the setting of air delivery. Please note that the Flowmeter is calibrated for air at 70°F and 14.7 PSIA.

There is a service manhole above the bottom flange. There are sample lines at several levels. This section of the column contains the Biolite™ media.

III. OPERATING INSTRUCTIONS

A. Pre Start-up

Ensure that all equipment is functional. Perform two backwash cycles if the unit has been in a long duration shutdown.

B. Start-Up

1. Filling the Column with Media

Remove the blind flange on the side opening of the column. Manually cover the nozzle heads with coarse gravel, taking care not to damage the process air lines. Level off the surface. This layer should be approximately 4" thick. Manually introduce the finer gravel and cover the Oxazur™ diffusers completely; the layer should be approximately 8" thick at the level of the bottom manway opening. Level the layer.

Fill the column with clean water up to the surface of the gravel. If the gravel is too dirty, wash it by filling and draining the tank several times. Drain the tank. Close the side opening. Fill the column with clean water to 1' below the bottom of the cone. Introduce the Biolite™ media from the top, taking care to evenly spread out the material until the desired level is reached. Once the tank is filled, partially drain the tank and level off the surface. Fill the tank up with clean water and leave the column for two days for proper material impregnation.

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2. Hydraulic Start-Up

Check proper installation of all equipment, making sure that the influent (raw water), effluent, and external control panel connections are all securely fastened. When the Biofor is to operate in the C or N mode, ensure that the process air blower is on. Open the appropriate service inlet and outlet valves. Confirm that sufficient water exists in the main influent tank.

C. Continuous Operation

Head loss should be monitored at regular intervals (pressure readings under the floor and water depth in the feed well). The head loss indicates the effectiveness of the washing cycle and the degree to which the filter media is being clogged during normal operation.

Measure head loss immediately after the completion of a wash cycle once process water flow has fully resumed. Also measure head loss at the end of the same operating cycle just prior to the next backwash cycle. Head loss should be measured with a constant process water flow. In addition, periodically monitor the pressure differential between the two walls of the support floor during the rinsing phase in order to monitor the condition of the nozzles.

Use these values along with water quality analysis to determine if problems may be occurring within the filter. Possible problems are as follows:

- Cycles are too long and overloaded
- Ineffective washing
- Clogging of nozzles
- Cycles are too short during start-up, thus not allowing adequate biomass growth

After steady-state conditions occur and water quality goals have been reached, proper inspection of the Biofor™ pilot plant should be regularly implemented. To ensure that the sequences are functioning properly, close attention should be given to the following matters:

- Visual inspection of the distribution of air at the surface during the various phases
- Proper operation of the valves (opening/closing)
- Proper diffusion of air scour
- Check of valves on compressors and pumps
- Reading of head losses during the wash cycle

It is recommended that normal backwashing sequences are performed every 24-48 hours after steady-state conditions occur. Energetic backwashes should be implemented monthly.

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D. Calculation Notes

a) Air flowmeters are usually calibrated at 70°F and 14.7 psia.

The reading shown on the instrument has to be corrected with the help of the following formula, as the air flowing through it is pressurized above 14.7 psia and may not be at 70°F.

$$SCFM = ICFM \sqrt{\left(\frac{Pi + Pa}{Pa}\right)\left(\frac{530}{460 + TA}\right)}$$

Where:

SCFM: Standard cubic feet per minute at 70ºF and 14.7 psia.
ICFM: Indicated cubic feet per minute on the instrument
Pi: Indicated pressure in psig at flowmeter outlet
Pa: Atmospheric pressure (14.7 psia)
TA: Air temperature (ºF)

b) Conversion from Nm^3/h to SCFM:

$$1\ Nm^3/h = 0.634\ SCFM$$

E. Pump Output

The output of the backwash water pumps and the delivery pressure must also be checked. In the event that the levels observed deviate noticeably from the reference values, consult Section VII. - Troubleshooting for further actions.

F. Pollution Control Performance Levels

Using analyses conducted on composite samples to determine soluble COD (Chemical Oxygen Demand) and BOD_5 (Biological Oxygen Demand), suspended solids efficiency and treated loads can be calculated.

Initial Cm and Final Cm = average initial and final concentrations in mg/l.
Vm water = average flow rate of water through the filters in gpm.
H = depth of Biolite™ filter media in ft.
Calculation of removal efficiency in %:

$$\frac{TREATED\ POLLUTION}{POLLUTION\ INTRODUCED} = 100\ x\ \frac{INITIAL\ Cm - FINAL Cm}{INITIAL\ Cm}$$

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Calculation of load (COD, BOD, or SS (Suspended Solids)): amount treated in kg per m^3 of Biolite™ media and per day

load = 24 x (initial Cm - final Cm) x Vm water/H

G. Operating Log / Log Forms

The operating log should be filled out on a daily basis. A suggested operation log sheet follows. It is recommended that hourly grab samples be taken and combined after a 24 hour period to determine the daily composite sample. These samples may be flow weighted.

BIOFOR™ UPFLOW BIOLOGICAL FILTER OPERATING LOG

(in mg/l) Week Ending / /								
DAY/DATE								
TSS	mg/l							
BOD_{5T}	mg/l							
BOD_{5S}	mg/l							
COD_T	mg/l							
COD_S	mg/l							
Total N	mg/l *							
$N\text{-}NH_4$	mg/l *							
Phosphorus	mg/l *							
pH *								
Alkalinity	mg/L $CaCO_3$ *							
Temperature	^oC							
BIOFOR™ EFFLUENT								
TSS	mg/l							
BOD_{5T}	mg/l							
BOD_{5S}	mg/l							
COD_T	mg/l							
COD_S	mg/l							
Total N	mg/l *							
$N\text{-}NH_4$	mg/l *							
Flow rate	gpm/ft^2							

(S = soluble)

* Only when nitrification is involved

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H. Monitoring Filter Washing

The washing of each filter must be inspected at least once a week. To ensure that the sequences are functioning properly, close attention should be given to the following matters:

- Visual inspection of the distribution of air at the surface during the various phases;
- Proper operation of the valves (opening-closing);
- Proper diffusion of air scour;
- Check of valves on blowers ;
- Reading of head losses during the wash cycle. Compare these values with the reference values determined at start-up.

Should the underdrain be overpressurized, the filter underdrain must be inspected and cleaned.

In addition, in order to maximize the operation of the Biofor^{TM}, it is important to adjust the duration of the operational cycles of the filters at regular intervals. This should be done according to load variations observed upstream of the filters. The duration of the operating cycles is seasonal and depends on the quality of the water to be treated.

I. Normal Backwashing Sequence

It is recommended that the normal backwashing sequence is performed every 24-48 hours. Keep in mind that only one Biofor^{TM} filter should be backwashed at a time.

The normal backwash sequence follows:

1. Quick Drain

Duration: (< 3 min) - The service inlet valve and outlet valves are closed and the backwash outlet valve and quick drain valve are opened. The influent feed pump stops. The process air blower stops running if the tank was in the nitrification mode. In this step, approximately 3 feet of water should drain in a minimum amount of time. This step continues until a set time is reached.

2. Air Cushion Formation

Duration: (< 2 min) - The backwash air blower is started and brought up to pressure. The quick drain valve and backwash air blower vent valve close. The backwash air inlet opens. Scour air is introduced into the plenum at a throttled rate of approximately 1.64 scfm/ft^2. The process air blower starts to run.

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3. Air Scour

Duration: (1 min. average - adjustable) - The backwash blower continues to run. The backwash air inlet fully opens to increase the scour air flow rate to approximately 3.83 scfm/ft^2. The air is distributed up through the nozzles and into the media. The media is expanded and the particles are agitated, loosening entrained material and excess biofilm on the Biolite™ media. The process air blower continues to run.

4. Air and Water Wash

Duration: (14 min. average - adjustable) - The air and water wash cycle consists of six (6) individually timed steps. In the first step, the backwash water pump is started and the backwash water inlet valve opens. The backwash air inlet valve remains open. The process air blower and the backwash air blower continue to run. The backwash rate for the first step is approximately 4.09 gpm/ft^2 for one minute. In the second step, the backwash flow control valve adjusts to allow the backwash rate to increase to approximately 8.18 gpm/ft^2. The second step lasts for three minutes. In the third step - rinsing, the backwash air inlet valve closes and the backwash air blower stops for two minutes. The air and water wash step - step four, along with the rinse step - step five, are repeated once more for three minutes and two minutes respectively. The cycle is completed with a three minute air and water wash step.

5. Air Cushion Purge

Duration: (2 min. average - adjustable) - The backwash air inlet valve closes and the backwash air blower stops. The air cushion is released via the air cushion vent pipe and valve to the atmosphere. The backwash water inlet valve remains open and the backwash air blower vent valve opens. The process blower and backwash water pump continue to run.

6. Rinsing

Duration: (10-12 min. average - adjustable) - This step disposes of the material loosened during the air scour steps to drain. The backwash water inlet valve remains open and the air cushion vent valve closes. The backwash water pump continues to run.

7. Rinsing/Cone Drain

Duration - (1-2 min.) - The process air blower remains on. The backwash water pump stops and the backwash inlet valve closes. The backwash rinse valve opens to drain the cone of any heavy solids.

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8. Water Process Washing

Duration: (10-15 min. average - adjustable) - The backwash valve closes. The service inlet valve is opened and the influent feed pump is started. Raw water passes through the filter, removing any remaining material loosened during the backwash steps.

9. Filter Preparation

Duration : (5 min. average - adjustable) - The service inlet valve closes and the influent feed pump stops. The launder to drain valve and effluent channel valve open, allowing the launder to drain to waste and effectively removing any material that may be entrapped in the launder If the tank is in the Dentrification mode, the process air blower ceases to run.

10. Return to Service

The launder to drain valve and the backwash outlet valve are closed. If the system requires filtration, the appropriate service inlet and outlet valves are opened. The influent feed pump starts. The process air blower continues to run if the tank is in the nitrification mode. If filtration is not required by the system, all valves close with the exception of the backwash air blower vent valve.

J. Modified Backwashing Sequence

1. 1st Quick Drain

The Influent pump is stopped and the quick drain valve is opened. The step will continue until the water reaches the desired level in the filter as set by ODI.

2. Air Cushion Formation

Duration: (2 min. average – adjustable) - The quick drain valve closes and the backwash air scour blower is started. When the air line is brought up to pressure, the backwash air inlet valve opens. Scour air is introduced into the plenum and is partially bled by the bypass valve forming the air cushion below the underdrain at a lower rate to ensure even distribution. The process air is again introduced into the filter and will remain on throughout the sequence except during the quick drain steps.

3. Air Scour

Duration: (1 min. average – adjustable) - The backwash blower continues to run and the air scour inlet valve remains open. The backwash blower VFD is controlled to provide airflow of 4.9 scfm/ft^2 through the nozzles and into the media. The media is expanded and the particles are agitated, loosening entrained material and excess bacteria on the Biolite™ media.

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4. 1st Air and Water Wash

Duration: (3 min. average - adjustable) - The air inlet valve remains open. The waste valve opens and remains open until the end of the backwash cycle. The backwash air blower continues to run. The backwash pump is started to supply the required backwash water flow. The backwash water flow rate control valve is modulated to provide 8.2 gpm/ft^2. The backwash inlet valve opens. Backwash water flows up through the filter.

5. 1st Rinse

Duration: (2 min. average - adjustable) - The backwash air inlet valve closes and the backwash air blower stops. Backwash water continues to flow at the same rate.

6. 2nd Quick Drain

The backwash pump is stopped and the backwash valve is closed. The quick drain valve is opened. The step will continue until the water reaches the desired level in the filter as set by ODI.

7. 2nd Air and Water Wash

Duration: (3 min. average - adjustable) - The backwash air blower starts to run and the air inlet valve opens. The backwash pump starts and the backwash inlet valve opens. Backwash water flows up through the filter.

8. 2nd Rinse

Duration: (2 min. average - adjustable) - The backwash air inlet valve closes and the backwash air blower stops. Backwash water continues to flow through the filter.

9. 3rd Quick Drain

The backwash pump is stopped and the backwash valve is closed. The quick drain valve is opened. The step will continue until the water reaches the desired level in the filter as set by ODI.

10. 3rd Air and Water Wash

Duration: (3 min. average - adjustable) - The backwash air blower starts to run and the air inlet valve opens. The backwash pump is started and the backwash inlet valve opens. Backwash water flows up through the filter.

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11. Air Cushion Purge

Duration: (2 min. average – adjustable) - The backwash air inlet valve closes and the backwash air blower stops. The air cushion is released to atmosphere via the air cushion vent valve. Backwash water continues to flow through the filter.

12. Final Rinse

Duration: (10 min. average – adjustable) - The backwash water inlet valve remains open and the backwash pump continues to run disposing of material loosened during the backwash steps.

13. Filter to Waste

Duration: (5 min. average – adjustable) - The backwash pump stops and the backwash water inlet valve closes. The influent valve opens sending raw water through the filter to remove any remaining material loosened during the backwash steps.

When the backwash sequence is completed the Biofor™ cell either returns to filtration or is placed in the standby queue depending upon the current flow demand.

L. Energetic Backwashing Sequence

Once every 1-1.5 months or as needed the filter should be placed in an energetic backwash, which uses a higher velocity backwash flow. The operator selects the backwash mode from the process control system.

1. Quick Drain

Duration: (< 3 min.) - The service inlet valve and outlet valve are closed and the quick drain valve and backwash outlet valve are opened. The influent feed pump and the process air blower stop running. This step continues until a set time is reached.

2. Air Cushion Formation

Duration: (< 2 min.) - The backwash air blower is started and brought up to pressure. The backwash air blower vent valve and quick drain valve close. The backwash air inlet opens. Scour air is introduced into the plenum at a throttled rate of approximately 1.64 scfm/ft^2. The process air blower starts to run.

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3. Air Scour

Duration: (1 min. average - adjustable) - The backwash blower continues to run. The backwash air inlet fully opens to increase the scour air flow rate to approximately 3.83 scfm/ft^2. The air is distributed up through the nozzles and into the media. The media is expanded and the particles are agitated, loosening entrained material and excess biofilm on the Biolite™ media. The process air blower continues to run.

4. Air and Water Wash

Duration: (9 min. average - adjustable) - The air and water wash cycle consists of four (4) individually timed steps. In the first step, the backwash water pumps are started and the backwash water inlet valve opens. The backwash air inlet valve remains open. The process air blower and the backwash air blower continue to run. The backwash rate for the first step is approximately 4.09 gpm/ft^2 for one minute. In the second step, the backwash flow control valve adjusts to allow the backwash rate to increase to 12.28 gpm/ft^2. The second step lasts for three minutes. In the third step - rinsing, the backwash air inlet valve closes and the backwash air blower stops for two minutes. The cycle is completed with a three minute air and water wash step.

5. Air Cushion Purge

Duration: (2 min. average - adjustable) - The backwash air inlet valve closes and the backwash air blower stops. The backwash air blower vent valve opens. The air cushion is released via the air cushion vent pipe and valve to the atmosphere. The backwash water inlet valve remains open. The process blowers and the backwash water pumps continue to run.

6. Rinsing

Duration: (7-8 min. average - adjustable) - This step disposes of the material loosened during the air scour steps to drain. The backwash water inlet valve remains open and the air cushion vent valve closes. The backwash water pumps continue to run.

7. Cone Drain/Fast Drain

Duration: (3 min. average - adjustable) - The process air blower stops. The backwash water pumps stop and the backwash water inlet valve closes. The backwash rinse valve opens to drain the cone of any heavy solids. The quick drain valve opens. This step continues until a set time is reached.

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8. Filter Preparation

Duration: (< 5 min.) - The quick drain valve closes. The backwash rinse valve closes. The launder to drain valve opens, allowing the launder to drain to waste and effectively removing any material that may be entrapped in the launder. The process air blower is restarted.

9. Return to Service

The launder to drain valve and the backwash outlet valve are closed. If the system requires filtration, the appropriate service inlet and outlet valves are opened and the influent feed pump starts. The process air blower continues to run. If filtration is not required by the system, all valves close with the exception of the backwash air blower vent valve.

IV. Stopping Procedures

A. Short Duration Shut-Down

If the system is going to be out of service for just a few hours, run the process air blower at regular intervals during the shutdown period.

B. Long Duration Shut-Down

If the filters need to be shut down for a long period of time, backwash the filter twice. Then completely drain the filter. After draining, aerate the filter media (scour air and process air) for one hour after draining the water.

C. Emergency Stopping

When stopping the filters in an emergency situation, simply close the inlet and outlet valves and turn off all operating equipment.

V. Maintenance

A. Electromechanical Equipment

Referring to Section VII - Troubleshooting of this instruction and Section D – Vendors in this manual, periodically service the pumps, compressors, blowers, water analysis equipment, etc.

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B. Treated Water Outlet

Regularly clean the filter overflows and the bottoms of the various channels in order to remove algae deposits.

If required, clean the water level sensors in the filters as well.

C. Filter Bottom

The frequency with which filter plenums should be cleaned will be affected by the amount of suspended solids present in the water introduced into the plenum and/or by the indication of a high head loss in the floor.

Once the filter has been completely emptied, the plenum should be inspected through the manhole. Clean the nozzles, one by one if necessary. (Exercise caution when using a pressurized water jet; it can propel grease deposits in the stem of the nozzle into the head and clog it.) The extent to which the floors are clogged will indicate whether the present operational settings are sufficiently cleaning the filter.

D. Process Air Network

The process air network should be cleaned monthly using pressurized water as follows:

- Shut down the process air blower.
- Close the filter process air inlet valve.
- Open the flush water inlet valve.
- Open the valves connecting the flush water inlet to the process air piping network.
- Rinse for 15 minutes. Open and close the flush valve several times during the rinsing. This helps dislodge solids caught in the network.
- Close the flush valve.
- Start up the process air blower.
- Open the process air inlet valve.

E. Treated Water Supply Tank and Backwash Storage Tanks

Tanks will need to be well mixed or emptied periodically to remove any sludge deposits.

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VI. Troubleshooting

The most common operational problems and remedies are shown in the following tables. Depending on the facility in question or the type of treatment involved, the remedial actions recommended may be modified or supplemented.

A. Process Air

UNEVEN PROCESS AIR DISTRIBUTION

Probable cause	Actions
Clogging of OXAZUR diffusers	Clean process air diffusion circuit with water as previously described.
Leak in the process air network	Inspect pipe systems, valves, bleed-off, for leaks.
Efficiency loss in the blower	Check the blower and the filter. Check blower manufacturer's literature.

UNEVEN DISTRIBUTION OF PROCESS AIR WITH EXTENSIVE UN-AERATED AREAS PERSISTING EVEN AFTER THE NETWORK HAS BEEN WASHED

Probable cause	Actions
Extensive clogging of the filtering material	Make sure the backwash cycle is properly operating (starts at proper time, correct sequence of valve operation, adequate delivery of backwash water and air). The frequency of backwashing may need to be increased.

UNEVEN DISTRIBUTION OF PROCESS AIR WITH LOCALIZED, VERY POWERFUL BUBBLING

Probable cause	Actions
Tear in one or more of the diaphragms of the OXAZUR diffuser	Replace damaged diaphragms as follows: Remove the filtering media from the filter.

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Tear in one or more of the diaphragms of the OXAZUR diffuser	Replace the defective diffuser. Determine the cause of the tear in the diaphragm. Perform further checks on the network to ensure proper operation of the unit before reloading the filter media. Be sure to follow media loading instructions carefully when reloading media.

B. Hydraulic Operation

HIGH HEAD LOSS THROUGH FILTERS IN SERVICE

Probable causes	Actions
Clogging of the floor and/or filtering material	Make sure the wash cycle is operating properly (starts at proper time, correct sequence of valve operation, adequate delivery of backwash water and air). Additional washing of filters during normal operation or manual operation with an extended air wash sequence may be required. Check for adequate backwash water and air flows.

HIGH HEAD LOSS THAT PERSISTS DESPITE ADDITIONAL WASHINGS

Probable cause	Actions
Severe clogging; low degree of effectiveness of washing	Provide for more extensive counter-current (downflow) draining; water flowing through the nozzles should help dislodge any matter caught in the slots or stem. Backwash again with the water flow-rate increased from 8.18 gpm/ft^2 to 12.28 gpm/ft^2; to do so, start up the back-up washwater pump; wash using the same time frames as previously (unless there is a risk of the capacity of the washwater tank or the used water storage tank being

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	exceeded), or repeat the air-water sequence twice with intermediate rinsing.

HEAD LOSSES REMAIN HIGH DESPITE ADDITIONAL WASHINGS AT ELEVATED RATE

Probable cause	Actions
The filtering material and/or floor remain highly clogged; washings ineffective	If the filter can only be shut down for a few hours, completely empty it, open the manhole, and clean the nozzles. If operations make it possible to shut the filter down for a few weeks, leave it in a state of anaerobiosis, without any water flow-through or process air.

HEAD LOSSES, JUST AFTER WASHING, INCREASE REGULARLY FROM ONE CYCLE TO ANOTHER

Probable cause	Actions
Washing is not sufficiently effective	If the pollution load is normal, backwashing has been inadequate.
Washing is not sufficiently effective	Determine pump output or amount of washwater; if too low, increase the duration of the backwash water steps so as to maintain constant total volume of backwash water delivery. Clean pump impellers; if the performance levels remain low with respect to the theoretical output curves, inspect and/or replace them. If the pollution load is momentarily high, initiate another backwash; wash frequency is based on the ratio of current load to theoretical load. Increase the backwash frequency as the filter loading increases.

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C. Air Scour

UNEVEN DISTRIBUTION OF AIR SCOUR

Probable cause	Actions
Clogging of filtering material and/or underdrain	See problems with high head losses.
Broken or unscrewed nozzle	Remove filtering media from the filter. Replace broken nozzles. Re-check the nozzles and the floor for integrity.

REDUCED AIR SCOUR OUTPUT

Probable cause	Actions
Blower performance levels decrease	Check blower installation, check lubrication. Clean/change filter. Refer to blower manufacturer's literature.
Leak in the air circuit	Check pipes. Check air venting from the safety valve; if necessary, re-calibrate.

D. Filter Output Levels

LOW REMOVAL EFFICIENCY LEVELS OF COD, BOD, AND SUSPENDED SOLIDS

Probable cause	Actions
Poor distribution of process air	Refer to air process troubleshooting. Excessive average and/or instantaneous water flow rate.
Poor washing of filters and probably poor distribution of fluids	Refer to hydraulic operation troubleshooting.

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Existing concentrations in the raw water of COD, BOD, and suspended solids that differ from the usual concentration levels	Check the COD/BOD_5 ratio.
If problem seems specific to the suspended solids	Check the service flow rates. In the event of large fluctuations in flow rate (zero flow rate, high flow rate sequence), try to regulate the throughput (a constant average flow rate improves performance).

PROPER SUSPENDED SOLIDS OUTPUT BUT LOW COD AND BOD OUTPUTS

Probable cause	Actions
High proportion of soluble COD that is not very biodegradable (COD/BOD_5 ratio > 2.5)	Is there industrial wastewater? Check and improve grease removal and pre-settling.
Presence of toxic matter	Determine their nature and origin.

PROPER REMOVAL EFFICIENCY LEVELS BUT EXCESSIVELY HIGH END CONCENTRATIONS OF SUSPENDED SOLIDS, COD, AND BOD

Probable cause	Actions
Excessively high initial concentration levels (poorly functioning grease trap and preliminary settling tank and/or initial concentration in excess of estimated amounts)	Ensure proper operation of upstream treatment, i.e. screening, grit removal, and preliminary settling, etc.

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EXHIBIT L

BROWN AND CALDWELL HEALTH AND SAFETY PLAN

BROWN AND CALDWELL

SITE SAFETY AND HEALTH PLAN

for

Biological Aerated Filter Phase I Pilot Test

PROJECT NO. 24901

Prepared by: Victor Occiano Date: December 2003

Reviewed/Approved by: Anne Baptiste Date: 12-31-03
Anne Baptiste, CIH
Health and Safety Director

Reviewed/Approved by: _____ Date: 12/31/03
Victor Occiano, P.E.
Project Manager

Effective Dates: December 2003 to December 2004

Note that this document was prepared for/by Brown and Caldwell employees.

BROWN AND CALDWELL
SITE SAFETY AND HEALTH PLAN

FIELD ACTIVITIES

This site safety and health plan (**SSHP**) has been prepared for field activities at the Point Loma Wastewater Treatment Plant (PLWTP) where the biological aerated filter (BAF) pilot test facility is located. Brown and Caldwell (BC) is providing consulting services related to this project to the City of San Diego for a period of approximately one year. The goal of the project is the evaluation of the performance of two BAF units manufactured by Ondeo-Degremont, Inc. and US Filter-Kruger, and a high rate clarifier/thickener (HRC/T) to treat raw and advance primary-treated wastewater at the PLWTP. A critical component of the study is the sampling program and pilot study program. Wastewater samples are expected to be collected as part of the sampling program, and will require fieldwork on site.

This SSHP outlines the hazards that may be encountered during fieldwork, and the preventive measures necessary for the protection of field personnel from these hazards, and is to be used in conjunction with the BC Health and Safety Manual, which contains detailed BC health and safety standard operating procedures. Field activities will include periodic site visits and walkarounds, and sampling of influent and effluent pipelines to and from the pilot test units. Field personnel will consist of one BC personnel plus one or two staff members from the City of San Diego. Confined space entry by BC or its subcontractors is prohibited under this plan.

KEY PERSONNEL AND RESPONSIBILITIES

The key BC personnel for this project include: Victor Occiano, project manager (**PM**); Joshua Newman, Project Engineer and Field Coordinator (**PE/FC**); Nicholas Boswell, Site Safety Officer (**SSO**); and Anne Baptiste, Health and Safety Director (**HSD)**. Specific project safety responsibilities for these key personnel are detailed below. This **SSHP** has been developed for BC field personnel use only. Forms that are attached to this SSHP are to be used in accordance with the Illness and Injury Prevention Plan (IIPP) of the BC H&S Manual. Notices of unsafe conditions are to be issued at the discretion of the Project Manager upon notice from the **SSO** or **FC**.

PM Responsibilities

The **PM** is responsible for generating, organizing, and compiling the **SSHP** which describes all planned field activities and potential hazards that may be encountered at the site. The **PM** is also responsible for ensuring that adequate training and site safety briefing(s) are provided to the project field team. The PM has provided a copy of this SSHP to each member of the project field team and subcontractor(s), if any.

HSD Responsibilities

The **HSD** is responsible for developing and coordinating the BC health and safety program. For specific projects, the **HSD** is responsible for reviewing and approving the **SSHP** for accuracy and incorporating new information or guidelines which aid the **PM** and **PE/FC** in further definition and control of the potential health and safety hazards associated with the project.

PE/FC Responsibilities

The **SSO** has on-site responsibility for ensuring that all team members, including any subcontractor(s), comply with the **SSHP**. It is the **SSO's** responsibility to inform the subcontractor(s) and other field personnel of hazardous conditions, as he or she becomes aware of them. Additional **SSO** responsibilities include:

1. Providing site safety briefing for team members.

2. Updating procedures to be used on site based on new information gathered during the site investigation.

3. Assisting the PM in documenting compliance with the SSHP by completing the standard forms.

4. Inspecting all PPE before on-site use.

5. Reporting to the PM all facts pertaining to incidents that result in injury or exposure to toxic materials.

6. Maintaining records including location and route to the nearest medical facility; arranging for emergency transportation to the nearest medical facility if necessary.

7. Maintaining the telephone numbers of local public emergency services; i.e., police and fire.

8. Stopping operations that threaten the health and safety of the field team or surrounding populace.

9. Observing field team members for signs of exposure, stress, or other conditions related to pre-existing physical conditions or site work activities.

Project Field Staff Responsibilities

The project field staff are responsible for ensuring that all data acquisition is performed in accordance with the work plan and **SSHP**, and that deviations from the plans are based upon field conditions encountered and are well documented in the field notes. The project field staff's health and safety responsibilities include:

1. Following the SSHP.
2. Reporting to the SSO any unsafe conditions or practices.
3. Reporting to the SSO all facts pertaining to incidents which result in injury or exposure to toxic materials.

Subcontractor Responsibilities

All subcontractors are responsible for their own health and safety program and the health and safety of their own employees. This requirement is based on Occupational Safety and Health Administration (OSHA) regulations, which recognize the employer-to-employee responsibility for health and safety. A copy of their written program must be submitted for review to the project manager, if requested. In an effort to assist the subcontractors, and to comply with hazard communication requirements, the project manager will provide a copy of the **SSHP** for this project to each subcontractor for implementation by the subcontractor's employees.

SAFETY AND HEALTH RISK ANALYSIS

The potential hazards to personnel working at the subject site(s) have been identified as chemical hazards, biological hazards, hazardous atmospheres, traffic concerns, physical hazards, heat stress, snakes and spiders, sunburn, and noise. Chemical hazards are also anticipated on this project. Each potential hazard is described below in more detail, including control measures and level of personal protective equipment (PPE) to be used.

Anticipated field activities include inspection of pilot test facilities, including the pilot test influent pump station, pilot test units, electrical connections and instrumentation, and associated pipelines. BC personnel will conduct the field activities and record the findings. Entry into permit-required confined spaces is <u>not</u> anticipated for these field activities. A confined space entry occurs when any parts of the body break into the plane of the confined space entry opening. However, in the event that the performance of the scope of work requires entrance into an area with restricted access (such as by way of a ladder or hatch) which contains conditions (such as sanitary sewer piping or gas piping) conducive to the formation and/or collection of hazardous gases, unknown debris, hazards such as asbestos, or electrical hazards, the area shall not be entered by field personnel. The area shall be noted and the **PE/FC** notified, who will arrange for further evaluation of the area of concern and determine an acceptable and safe method of data gathering at that area, in consultation with the **PM**.

Chemical Hazards

As part of the scope of this project, BC will evaluate the effectiveness of a NRC/T unit that requires the addition of iron chloride and polymers for coagulation and flocculation. During field activities, it is possible that field personnel may come in contact with these chemicals. Chemical hazards that field personnel on this project may encounter are primarily associated with exposure to the following chemicals:

Iron Chlorides

$FeCl_2$ and $FeCl_3$ are strong reducing-oxidizing agents used in the wastewater industry primarily for odor control and flocculation of suspended solids, sometimes in conjunction with other chemicals. When used for odor control, iron chlorides may be administered into wastewater collection systems as solutions ranging in strength from 30% to 70%. Iron chloride solutions do not pose a fire hazard, but may react violently with certain organic compounds. Solutions of iron chloride are acidic in nature, and exposure to skin may cause irritation. Solutions of iron chloride may also give off noxious fumes, which may irritate the respiratory tract. PPE to be utilized when directly handling iron chlorides include latex gloves, safety glasses and disposable tyvek coveralls, as appropriate. If exposure to solutions of iron chlorides occurs, wash the affected areas immediately with running water, and then with water and soap. In case of eye contamination, there will be an eye wash unit on site.

The polymer is not considered to be a hazardous chemical. However, a Material Safety Data Sheet will be obtained and attached to this plan. Also any spillage hazard will be noted if spillage occurs.

Biological Hazards

During the collection of field samples, field personnel may come in contact with pathogens present in untreated wastewater, unless adequate precautions are taken. Exposure to these pathogens may include diseases such as Hepatitis A, dysentery, typhoid and gastroenteritis. The best method of preventing contact with pathogens is the use of appropriate PPE, such as latex gloves and tyvek coveralls when collecting or handling untreated wastewater and meticulous personal hygiene which includes soap and water washing during decontamination. Adequate care must also be taken to ensure that activities such as eating, drinking or smoking etc. are not conducted before thoroughly washing hands and arms with soap and water. Tetanus and Hepatitis A vaccinations are available to employees through BC's medical provider upon request. Precautions for aeration and possible aerosolization of wastewater include setting up operations in well-ventilated areas away from other clean work operations. Facemasks (N-95) should be optional for worker who needs assistance to prevent hand to face contact.

Hazardous Atmospheres

Health hazards from hazardous atmospheres are primarily associated with potential exposure to hydrogen sulfide (H_2S) at the job site(s). Toxicity may occur following inhalation of H_2S released from the wastewater collection and pumping systems. Hydrogen sulfide may be present in the work area due its release from the wastewater. It is anticipated that normal atmospheric dilution will reduce H_2S

concentration to levels below 10 PPM in unconstrained conditions. This concentration is under the OSHA and NIOSH recommended time-weighted average exposure limit of 10 PPM. (This limit applies for up to a 8-hour workday during a 40-hour workweek). Nonetheless, it is recommended that occasional readings of the H_2S concentration immediately in the work zone be taken and documented during the course of the sampling program, particularly during initial approach, opening and sampling activities or if an area of noticeably stronger odor is encountered. It is possible that subsurface conditions may be responsible for locally elevated H_2S concentrations. The properties of hydrogen sulfide and methane gas are as follows:

H_2S is irritating to the eyes and respiratory system, with slight to severe irritation and possible death by respiratory paralysis as concentrations increase. The current Threshold Limit Value (TLV) for H_2S is 10 ppm as an 8-hour time-weighted average. The current immediately dangerous to life and health level (IDLH) is 100 ppm within a few minutes exposure. H_2S is a colorless gas with a characteristic rotten-egg odor and is soluble in water. Its odor cannot relied upon for hazard detection as olfactory fatigue rapidly sets in. Hence, cartridge respirators are ineffective protection from exposure. Symptoms include eye, nose and throat irritation, a dry cough, breathlessness (it causes respiratory paralysis), nausea and vomiting and in sufficient concentrations, death. H_2S also presents a fire hazard if present in high enough concentrations; flammable range is 4% to 44% in air – these extreme levels are not expected.

Methane is an odorless, colorless, flammable gas that is lighter than air. It replaces oxygen in air as a simple asphyxiant. It presence is measured and detected with a combustible gas meter, LEL and oxygen sensors.

Traffic Concerns

During the course of field activities at the various job sites, vehicular traffic in the form of cars, trucks, buses, etc., may be present. It is important to be conscious of all vehicular traffic that may be present during field operations. The use of caution tape, barricades, or safety cones to denote the boundaries of the work area and to alert vehicle operators to the presence of operations which are non-routine to them is recommended. Field staff should be careful when exiting the work area and especially when walking out from between parked vehicles to avoid vehicular traffic.

Traffic control priorities are, in order of importance:

Warning lights
Signs
Flaggers
Cones

When possible, field staff shall park field vehicles off shoulder, in a parking lot or in an area not normally reserved for constant vehicular traffic. If this is not possible, the field vehicle shall be parked in a manner that is deemed safest for conditions. Warning lights and headlights shall then be turned on if required, to alert motorists. Further warnings or controls such as signs, flags and cones may be used if necessary.

Work on roadways and traffic diversions are not authorized for this project unless prior planning, which includes mapping of the traffic control and in some cases obtaining traffic control support, is provided for these locations. When walking in a roadway either setting up or taking down traffic controls, field staff shall face approaching traffic. If this is not possible, the second field person shall watch oncoming traffic and alert the other person verbally or by signaling, as needed. Whenever possible, the field vehicle should be placed between the worksite and oncoming traffic. The wheels of the field vehicle should be turned away from the worksite and from traffic lanes if possible, to minimize impact if struck. If at any time the **SSO** or **PE/FC** determines that conditions are unsafe for conducting field activities, he or she shall halt work and inform the **PM** so that additional measures may be taken for protection of field staff. The BC staff will check in with prime construction contractor daily.

Physical Hazards

Accidents involving physical hazards can directly injure field personnel. One of the most common potential hazards is improper bending and lifting which may result in back injuries. Field personnel should maintain awareness of potential safety hazards at each specific site, and should immediately inform the **SSO** of any new hazards so that corrective measures may be taken.

Back Strain

BC personnel are generally aware of such hazards and will implement proper lifting techniques and will address each lift on a case-by-case basis. Back strain prevention techniques include obtaining the proper tools prior to site work, performing two person lifts, and acquiring motorized equipment when loads are too heavy or awkward to move. Tool options include extended handles, hooks, tools that use fulcrum force to slide, rather than lift manhole covers, mechanical jacks etc. Motorized equipment may include winches attached to vehicles and forklifts. Examples include pumping samples instead of opening manholes or lifting and pouring as well as smaller ice chest for transporting samples.

Heat Stress

The potential for heat stress is a concern when field activities are performed on warm, sunny days. Heat stress prevention measures and monitoring will be implemented if ambient temperatures are above 70 degrees Fahrenheit (F).

General Precautions

Precautions to prevent heat stress consist of regular intake of water to replace fluids lost due to sweating. If at any time field team members recognize the signs or symptoms of heat stress, they should notify the **SSO** immediately so that a rest period can be called.

Heat stress due to water loss can be prevented. To prevent dehydration, water intake must approximate sweat loss. Water intake guidelines are as follows:

1. The sense of thirst is not an adequate indicator of water replacement needs during heat exposure. Therefore, water must be replaced at prescribed intervals.

    a. Before work begins, drink two 8-ounce glasses of water.
    b. During each rest period, drink at least two 8-ounce glasses of water.

2. Plain water, served cool, is the best replenishment for lost fluids. An adequate supply of drinking water (at least one gallon per person per day) and clean cups will be readily available (i.e., at the support vehicle) to provide water during rest periods.

3. Adding salt to water is not recommended. However, other fluids, in addition to water, could include fruit juices and diluted electrolyte replacement drinks (diluted 3:1 with water). **Do not use salt tablets!**

Heat stress, if not prevented, results in heat stress illnesses. Two critical illnesses, if not recognized and treated immediately, can become life-threatening. These are heat exhaustion and heat stroke. Heat exhaustion will result if the prevention measures described above are not implemented. Ignoring the signs and symptoms of heat exhaustion will lead to the development of heat stroke. Heat stroke is an immediate, life-threatening condition that occurs because the body's heat regulating mechanisms shut down, and the body cannot cool itself sufficiently. Excessive heat stored in the body can cause brain damage, resulting in permanent disability or death.

Heat Exhaustion

The signs and symptoms of heat exhaustion include headache; dizziness; nausea; weakness; fainting; profuse sweating; loss of appetite; approximately normal body temperature; dilated pupils; weak and rapid pulse; shallow and rapid breathing; possible cramps in abdomen and extremities; possible vomiting; difficulty walking; and **skin that is cool and sweaty to the touch with pale to ashen-gray coloring.**

First aid for heat exhaustion is as follows:

Immediately remove victim to a cool area; if you are the victim, go to a cool area.

Start cooling, but be careful not to cause a chill (i.e., rest in shade and apply wet towel to forehead; open up and/or remove clothing as much as practical).

Drink cool water slowly, but only if conscious and not in shock.

If vomiting, and/or the signs and symptoms are not lessening within an hour, call for emergency help and/or transport the victim to emergency room.

It is likely that a heat exhaustion victim will be unable to work for the remainder of the day.

Heat Stroke (AKA sunstroke)

The signs and symptoms of heat stroke are **hot, dry skin to the touch with reddish coloring**; body temperature >105 degrees F; no sweating; mental confusion; deep, rapid breathing that sounds like snoring progressing to shallow, weak breathing; headache; dizziness; nausea; vomiting; weakness; dry mouth; convulsions; muscular twitching; sudden collapse; possible unconsciousness.

First aid for heat stroke is as follows:

1. Immediately remove the victim to a cooler area.

2. Cool the victim rapidly using whatever means are available, such as shade, opening up and/or removing clothing, soaking clothing/skin with water and fanning, placing victim in vehicle using air conditioning on maximum.

3. Do not give drinking water to victim.

4. Treat for shock, if needed.

5. Transport the victim to the emergency room or call for emergency help; no exceptions for heat stroke victim.

Slips, Trips, and Falls/Ergonomics

During field activities, work may occur in areas where piping or other equipment at ground level present possible slip, trip and fall hazards. In addition, wet weather conditions may also pose such hazards. Personnel must wear steel-toed boots during manhole inspection and sampling activities.

Snakes and Spiders

In the course of walking through seldom-used buildings or open areas, the potential exists for contact with snakes. Field personnel should take precautions to prevent bites by never stepping or reaching into a room, enclosure, or space which is not well lit. Steel-toed boots will be worn at all times. In many cases, contact with snakes can be avoided completely by making noise while walking. There is a possibility that black widow and brown recluse spiders may be present at some sites. Personnel should take precautions to clear the area of spider webs and other debris before working in that area.

Hanta Virus

Brown and Caldwell and subcontractor personnel working at a site with known evidence of a rodent population, particularly the deer mouse, must be made aware of an increased level of concern regarding the transmission of "Hanta Virus" associated diseases. The Hanta Virus is believed to be associated with rodents, especially the deer mouse, which serves as a primary reservoir host, and can result in fatalities. Employees are prohibited from entering areas where hanta virus contamination is highly likely without first contacting the **PM** and a **BC H&S** staff member.

The Hanta Virus can be spread by the saliva, urine and feces of infected rodents. Human infection may occur when infected wastes are inhaled as aerosols produced directly from the animals, or as dried materials introduced into broken skin or onto mucous membranes. Known infections of humans occur mostly in adults and are associated with activities that provide contact with infected rodents. Activities to be avoided are sweeping, dusting and other cleaning activities unless precautions are taken. Areas should be sprayed with a 5% solution of bleach and water, allowed to sit for a minimum of 15 minutes and then the debris may be swept up and thrown away.

Illness caused by the Hanta Virus begins with one or more flu-like symptoms (i.e., fever, muscle aches, headache and/or cough), and progresses rapidly to severe lung disease and may cause death. Early diagnosis and treatment are vital.

Animal Droppings

Due to the fact that certain project sites may be a haven for animals or birds, there may be a significant amount of droppings in some areas. In areas where there is evidence of extensive animal droppings, particularly bird droppings, persons entering the area should be equipped with and required to use dust (N-95) type respirator (dust mask) or a PPE device, if required. Unless the individual is crawling or doing excessive hands-on work at the project site, there should not be a need for other protective clothing. If, however, there is excessive contact, sampling, or movement in the immediate area of the droppings, then gloves and coveralls should be used.

Field Precautions to Avoid Hanta Virus

Personnel entering areas where rodents and the presence of the Hanta Virus is known or suspected need to take personal protective measures. Field personnel must wear respirators with high efficiency particulate air (HEPA) filters, eye protection, chemical resistant coveralls, chemical resistant gloves and disposable boot covers if there is any potential for direct contact with rodents or their wastes. Strict decontamination requirements must be followed. When working in rural/semi-rural areas, the following risk reduction strategies should be implemented:

Eliminate rodents and reduce availability of food sources and nesting sites used by rodents.
Store trash/garbage in rodent-proof metal or thick plastic containers with tight lids.
Cut tall grass/underbrush in close proximity to buildings.
Prevent rodents from entering buildings.

Sunburn

Working outdoors on sunny days for extended periods of time can cause sunburn to the skin. Excessive exposure to sunlight is associated with the development of skin cancer. Field staff should take precautions to prevent sunburn by using sunscreen lotion and/or wearing hats.

Noise

Noise is a potential hazard in areas where equipment is operated, such as pump rooms or high traffic areas. Equipment operation may produce noise levels that reach or exceed 85 decibels (dBA), the action level established by the OSHA. Exposure to elevated noise levels can lead to temporary or permanent hearing loss, and can also cause muscle tension and irritability. The **SSO** will ensure hearing protection is utilized when noise levels are elevated. Elevated noise levels will be evaluated by the **SSO** when equipment is operated. Excess noise levels may be estimated using the following rule of thumb: When normal voice communication is not possible between field personnel who are no more than three feet apart, hearing protection must be utilized. Hearing protection typically involves the use of disposable ear plugs for the duration of the excessive noise level, and will be used by field personnel while in areas that present a noise hazard.

In the event of any of the following, work shall be discontinued pending direction of the **HSD**:

Air Monitoring

Continuous air monitoring for health and safety reasons is not anticipated for the majority of this project since intrusive work will not be performed and most work will be performed in normal operating conditions at well ventilated sites. However, monitoring of H_2S must be performed on a continuous basis for evaluating effectiveness of chemical addition in reducing H_2S concentrations, and may be used as an indicator of hazardous conditions, if required. **Confined Space Entry (i.e. when the body breaks the plane of a confined space opening) is not authorized for this project.** Initial monitoring (for CO, O_2, LEL and H_2S) will be performed when opening manhole covers. Monitoring procedures and documentation should be performed in accordance with the BC Manual, Section 404. Section 404 of BC's Safety Manual is attached to this safety plan along with Attachment E - monitoring documentation form.

Work shall be suspended when:

Initial survey suggests presence of buried containers or unidentifiable unnatural material (excluding utilities).

Unnatural discoloration of soil is noticed.

Odors other than those typically associated with domestic raw sewage are detected.

Symptoms of possible exposure occur in any individual while on the job (symptoms include eye, throat, or skin irritation; nausea, dizziness, light-headedness, blurred vision, lack of muscle coordination, and vomiting).

Samplers dropped in manhole openings cannot be retrieved with hooks and lines or other means not requiring entry of personnel into confined spaces.

Action levels are exceeded for initial LEL monitoring. These include detection of < 19% oxygen, > 23.5 % oxygen, > 10% LEL or > 10 PPM H_2S at 18 inches above the manhole rim upon opening manholes or other structures such as closed rooms.

Additional caution is recommended in the vicinity of uncontrolled/unmonitored sections of collection systems, or when illegal dumping of septic waste and unknown chemicals is suspected.

Upon suspending work, the **PE/FC** should direct the field personnel under BC control to move to a safe place identified by the **PE/FC** and shall advise personnel not under BC control to do the same. The **PE/FC** shall then inform the **PM** and **HSD** of the reasons why work was suspended and wait for instructions. If a determination is made that more rigorous air monitoring and control measures are required, an addendum to this plan will describe the monitoring method(s), action levels and control techniques.

EMPLOYEE TRAINING

All staff working on site will be familiar with the requirements of this **SSHP**, and will participate in site activity and safety briefings provided by the **SSO** as well as annual BC Fieldwork Safety Awareness training. The **SSO** has completed the required additional training for this project assignment, including first aid and CPR.

All subcontractor personnel directly involved with the field work must attend the site safety briefings conducted prior to starting field activities and as needed during the project.

PERSONAL PROTECTIVE EQUIPMENT

Based on the hazard analysis for this project, the following Personal Protective Equipment (PPE) will be required and used. Changes to these specified items of PPE will not be made without the approval of the **SSO**.

The minimum required personal protection during all field activities consists of slip resistant steel-toed boots, long pants, full-sleeved shirt, and safety glasses. If the field personnel so desire, disposable tyvek coveralls may be provided upon request. Hard hats will be available and must be used when in active construction areas. Ear plugs must be worn any time verbal communication becomes difficult to comprehend within a radius of three feet. Hard hats must meet American National Standards Institute (ANSI) approval. During sampling activities which involve the collection of sewage from manholes or other collection structures, disposable latex gloves or nitrile gloves shall be worn for protection. Other than gloves, recommended meticulous personnel hygene is with aggressive washing using soap and

water. Antibacterial cleaner can be used until can get a washing facility. If needed, tyvek coveralls may also be worn to prevent contact of sewage with exposed skin or personal clothing.

While P-100 particulate respirators may be used for protection against possible Hanta Virus exposure, cartridge respiratory protection is not authorized for protection against H_2S gases or oxygen deficiency, as cartridges are ineffective for these contaminants.

SITE CONTROL

This section describes the general facilities and site-specific control measures for this project. The potential physical hazards have been identified in this **SSHP**; however, should unexpected conditions arise, the **SSO** will stop all work at the site and notify the **PM**. Work will not resume until the working conditions have been reevaluated and the **SSHP** revised accordingly.

Communication between field team members will consist of verbal communication. It is not anticipated that field activities or work locations will interfere with this approach. However, in the event of an emergency where field team members must be alerted and verbal communication is not effective, a single long blast of the field vehicle horn and hand signals will be used to get their attention and indicate that everyone should gather at the field vehicle. Cellular telephones will be used for greater distances when service is available. As a precaution for lack of service to the area, a passive locator system (sign-in/sign-out and arranged meeting times/locations) will be implemented when distances are too far for a horn blast. In the event of an emergency, the **SSO** shall obtain help by dialing 911.

In the event of a medical emergency, it is advisable to seek help by dialing 911. However, for minor emergencies or injuries (i.e. back injury, sprained ankle, etc) with no threat to life or limb, the SSO may transport injured personnel to the nearest medical facility for treatment, if required. A list of hospitals or medical facilities nearest to work site(s) are listed below in the section titled "Contingency Plan". Field personnel are expected to review this information prior to commencement of field activities so that they are aware of the directions to the nearest medical facility. Route maps with directions are provided as attachments to this **SSHP**.

Work Practices

Safe work practices are part of assuring a safe and healthful working environment. These practices are standardized for all field activities, and it is the responsibility of all employees to follow safe work practices when conducting field activities. Safe work practices to be employed during the entire progress of fieldwork are as follows:

Do not use hands to wipe sweat away from face. Use a clean towel or paper towels.
Wash hands, face, and arms prior to taking rest breaks, lunch break, and leaving the site at the end of the workday.
Check in and out with the **PE/FC** upon arrival and departure from the site.
Notify the **PE/FC** immediately if there is an accident that causes an injury or illness.
Do not approach or enter an area where oxygen deficiency or toxic or explosive concentrations of airborne contaminants or gases may exist.

CONTINGENCY PLAN

In the event of an emergency on site related to project activities, the **SSO** will direct the course of action. It may be necessary for the **SSO** to depend on the other on-site personnel for assistance. The **SSO** will call for emergency assistance if needed. The following procedure will be implemented:

Remove the exposed or injured person(s) from immediate danger.

Render first aid if necessary.

Obtain paramedic service or ambulance transport to local hospital by calling 911. A BC field member shall accompany any person to the medical facility and remain with the person until release or admittance is determined.

Any accident/incident resulting in an OSHA-reportable injury or illness, treatment at a hospital or physician's office, property damage, or a near-accident, requires that an accident/incident report be completed and submitted to the HSD.

As soon as practical, the **SSO** shall contact the **PM** regarding the incident and request instructions for further action. All staff assigned to this project will be briefed on the emergency procedures and their responsibilities for implementation.

Maps and directions showing the locations of the nearest hospitals are included under a separate section titled Figures. **Emergency telephone numbers to be used to call for assistance are listed below.**

Urgent Care & More-Er	**Phone:** (619) 225-6200 3434 Midway Dr # 1002, San Diego, CA 92110
Sharp Rees-Stealy Medical Grp	**Phone:** (619) 446-1575 2001 4th Ave, San Diego, CA 92101
UCSD Healthcare	**Phone:** (619) 543-6400 200 W Arbor Drive, San Diego, CA 92103
Emergency:	Dial 911
BC Project Manager	Victor Occiano Brown and Caldwell 9665 Chesapeake Drive # 201 San Diego, CA 92123 (858) 514-8822 (619) 203-3077 Cell

SPILL CONTINGENCY PLAN

The implementation of a detailed spill contingency plan for this project is not necessary since it is covered under the City's Contingency Plans. In the event of a spill or tank failure, BC employees present at site shall follow the directives issued by City of San Diego operators, or vendor representatives present on site. In the event of absence of City of San Diego or vendor representatives, BC employees shall evacuate the site, move to a safe upwind location, and contact emergency services designated by the City of San Diego or the vendor.

DOCUMENTATION

The implementation of the **SSHP** must be documented to assure employee participation and protection. Documentation of the implementation of this plan will be accomplished using standard forms, Attachments A-E. An acknowledgment from each field team member that he/she has received and read a copy of the **SSHP** for this project will be obtained prior to the initiation of fieldwork for the project. The **PE/FC** is responsible for ensuring that each BC field team member has completed this form and sending a copy for each employee to the **HSD** for record keeping. The **PE/FC** is responsible for completing the other standard forms required for a documentation of **SSHP** implementation. Copies should be maintained in the project file.

FIGURES

Fig. 1. Map showing route from Gatchell Road to Urgent Care & More-Er

DIRECTIONS

1. Start at [2400-2489] CABRILLO RD, SAN DIEGO on GATCHELL RD - go < 0.1 mi
2. GATCHELL RD becomes CABRILLO RD - go 0.7 mi
3. Turn L on **CABRILLO MEMORIAL DR** - go **2.2** mi
4. Continue on **CATALINA BLVD** - go **1.6** mi
5. Turn R on **CHATSWORTH BLVD** - go **0.9** mi
6. Turn L on **NIMITZ BLVD** - go **0.9** mi
7. Continue on a local road - go **0.1** mi
8. Bear R on **W POINT LOMA BLVD** - go **1.0** mi
9. Bear R on **MIDWAY DR** - go **0.5** mi
10. Arrive at 3434 MIDWAY DR STE 1002, SAN DIEGO

Fig. 2. Map showing route from Gatchell Road to Sharp-Rees Stealy Medical Group

DIRECTIONS

Start at [2400-2489] CABRILLO RD, SAN DIEGO on GATCHELL RD - go < 0.1 mi

2. GATCHELL RD becomes CABRILLO RD - go 0.7 mi
3. Turn L on **CABRILLO MEMORIAL DR** - go **2.2** mi
4. Continue on **CATALINA BLVD** - go **0.9** mi
5. Bear R on **CANON ST** - go **0.2** mi
6. Turn R on **TALBOT ST** - go **0.6** mi
7. Turn L on **ROSECRANS ST** - go **0.5** mi
8. Turn R on **GARRISON ST** - go **0.1** mi
9. Turn L on **SCOTT ST** - go **< 0.1** mi
10. Turn R on **N HARBOR DR** - go **2.9** mi
11. Turn L on **W LAUREL ST** - go **0.9** mi
12. Continue on **LAUREL ST** - go **0.2** mi
13. Turn R on **4TH AVE** - go **0.4** mi

Fig. 3. Map showing route from Gatchell Road to UCSD Healthcare

DIRECTIONS

1. Start at [2400-2489] CABRILLO RD, SAN DIEGO on GATCHELL RD - go < 0.1 mi
2. GATCHELL RD becomes CABRILLO RD - go 0.7 mi
3. Turn L on **CABRILLO MEMORIAL DR** - go **2.2** mi
4. Continue on **CATALINA BLVD** - go **1.6** mi
5. Turn R on **CHATSWORTH BLVD** - go **0.9** mi
6. Turn L on **NIMITZ BLVD** - go **1.2** mi
7. Bear R to take **I-8 EAST/(I-5 S)** - go **4.1** mi
8. Take the **CA-163 SOUTH** exit towards **DOWNTOWN** - go **0.9** mi
9. Take the **WASHINGTON ST WEST** exit - go **0.2** mi
10. Turn R on **WASHINGTON ST** - go **0.3** mi
11. Turn R on **4TH AVE** - go **0.1** mi
12. Bear R on a local road - go **< 0.1** mi
13. Bear L on **4TH AVE** - go **0.1** mi
14. Turn L on **MONTECITO WAY** - go **0.2** mi
15. Turn R on **1ST AVE** - go **0.1** mi
16. Turn L on **W ARBOR DR** - go **0.1** mi
17. Turn R on **FRONT ST** - go **< 0.1** mi
18. Arrive at 200 W ARBOR DR, SAN DIEGO

Attachments

BROWN AND CALDWELL	**Attachment A Site Safety and Health Plan Employee Acknowledgment**

Employee Name

Project Name	Project Location	Project Number

Employee Statement of Acknowledgment

I hereby certify that I have read and that I understand the safety and health guidelines contained in Brown and Caldwell's Site Safety and Health Plan for the above-named project.

_____ _____

Employee Signature Date

In the Case of an Emergency, contact:

	Name	**Relationship**	**Phone Number**
1.			
2.			

Name of Site Safety Officer Receiving This Form

Signature of Site Safety Officer	Date

NOTE: Send completed form to Health and Safety Director.

BROWN AND CALDWELL	**Attachment B Site Safety and Health Plan** **Site Activity and Safety Briefing**

Name of Site Safety Officer	Signature of Site Safety Officer	
Project Name	Project Location	Project Number

Who attended the briefing?

Names of Brown and Caldwell Employees	**Names of Subcontractor(s) Employees**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

What items were discussed?

- ☐ Site Safety and Health Plan
- ☐ Specific Accident/Incident
- ☐ Protective Equipment to be Used
- ☐ Emergency Hospital Route
- ☐ Hazardous Site Conditions/Activities
- ☐ Changes/Solutions to Specific Accident(s)
- ☐ Location of Emergency Telephone Number
- ☐ Work Schedule
- ☐ Other _____

Do any items require assistance from BC Health and Safety staff? (If yes, describe the item and type of assistance required and contact the Health and Safety staff directly.)

☐ YES ☐ NO

_____

_____

_____

_____

NOTE: Place a copy of the completed form in the project file.

BROWN AND CALDWELL	**Attachment C Site Safety and Health Plan Safety Plan Implementation Checklist**	
Project Name	Project Location (city and state)	Date
Name of Site Safety Coordinator	Weather Conditions	Project Number

BC Staff Present

Name	Office

Indicate the status of each of the following:

1.	Is a copy of the Site Safety and Health Plan (SSHP) on site?	☐ YES	☐ NO	☐ N/A
2.	Is the personal protective equipment required by the SSHP available and being used correctly?	☐ YES	☐ NO	☐ N/A
3.	Have the work zones been delineated?	☐ YES	☐ NO	☐ N/A
4.	Has a decontamination station been set up as required by the SSHP?	☐ YES	☐ NO	☐ N/A
5.	Are the decontamination procedures being followed?	☐ YES	☐ NO	☐ N/A
6.	Is access to the exclusion zone being controlled?	☐ YES	☐ NO	☐ N/A
7.	Has the site activities briefing and tailgate safety meeting been provided?	☐ YES	☐ NO	☐ N/A
8.	Is the list of emergency telephone numbers posted at the support zone?	☐ YES	☐ NO	☐ N/A
9.	Are directions to nearest emergency medical assistance posted at support zone?	☐ YES	☐ NO	☐ N/A
10.	Is emergency equipment available and functional, as required by the SSHP?	☐ YES	☐ NO	☐ N/A
11.	Has the nearest toilet facility been identified or a portable facility been set up?	☐ YES	☐ NO	☐ N/A
12.	Has an adequate supply of drinking water been provided?	☐ YES	☐ NO	☐ N/A
13.	Has water for decontamination been provided?	☐ YES	☐ NO	☐ N/A
14.	Have the instruments for environmental and exposure monitoring been calibrated and set up as required by the SSHP?	☐ YES	☐ NO	☐ N/A
15.	Are the instruments being used properly and periodically checked during the shift for battery charge status?	☐ YES	☐ NO	☐ N/A
16.	Have the trenches and excavations been clearly marked?	☐ YES	☐ NO	☐ N/A
17.	Have trenches and excavations been shored or sloped as required by soil type and work activities?	☐ YES	☐ NO	☐ N/A
18.	Are dust suppression measures being used?	☐ YES	☐ NO	☐ N/A
19.	Is food and tobacco consumption being restricted to the support zone?	☐ YES	☐ NO	☐ N/A
20.	Has a confined space been identified as part of this project?	☐ YES	☐ NO	☐ N/A
21.	Are the confined space entry procedures being correctly implemented?	☐ YES	☐ NO	☐ N/A
22.	Has the work/rest cycle for the shift been established?	☐ YES	☐ NO	☐ N/A
	TIME ON (minutes): _____ TIME OFF (minutes): _____			
23.	Has a shaded rest area been set up in the support zone?	☐ YES	☐ NO	☐ N/A

NOTE: Place completed form in project file.

BROWN AND CALDWELL	**Attachment D** **Notice of Unsafe Conditions**

Contractor	Date
Project Name	Project Number

THIS NOTICE . . .

This notice is to advise you, the Prime Contractor on the above-named Contract, that this Representative of the Owner of the above-mentioned Project has observed (on the date shown above) an unsafe condition on the Project.

These conditions are listed as follows:

ITEM	CONDITION

By this Notice, the Owner or its Representatives shall not assume any responsibility under the GENERAL CONDITIONS or assume any liability for the existence or correction thereof, for the unsafe conditions, or any others that may have been unnoticed.

These conditions shall be remedied as soon as possible within a safe working period. If these corrections are not made, the Owner will be forced to remove all field staff from the job. No payment shall be made for any work installed after this date without first examination of work in accordance with the GENERAL CONDITIONS.

Signature of Owner's Representative	Title	Date
Received by (Signature of Contractor's Representative)	Title	Date

NOTE: Place a copy of completed form in project file.

BROWN AND CALDWELL

Attachment E Site Safety and Health Plan Environmental Monitoring Documentation

Project Name	Project Number

Employee Name	Project Location

Equipment Used (check as appropriate)

	Calibrated	Date	Used	Dates(s)
OVA (Organic Vapor Analyzer)/FID	☐	_____	☐	_____
OVM (Organic Vapor Monitor)/PID	☐	_____	☐	_____
HNU	☐	_____	☐	_____
PTLV Sniffer	☐	_____	☐	_____
Photovac TIP	☐	_____	☐	_____
Combustible Gas Meter/Explosimeter	☐	_____	☐	_____
Other _____	☐	_____	☐	_____

Instrument	Date	Time	Readout Value	Area Monitored	Changes in PPE			User's Initials
					YES	NO	Type of PPE	

NOTE: Place completed form in project file.

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION OF THE PRODUCT AND THE COMPANY

CLARIFLOC® MC-136

Supplier :

POLYDYNE INC.
PO Box 279
Riceboro, GA 31323
Tel : 912-884-8775 Fax : 912-884-8770

2. COMPOSITION/INFORMATION ON INGREDIENTS

Identification of the preparation : Anionic water-soluble polymer

The product is not considered hazardous in accordance with OSHA Federal Regulation 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION

Spills produce extremely slippery surfaces.

4. FIRST AID MEASURES

Inhalation : Move to fresh air.

Skin contact : Wash with water and soap as a precaution. In case of persistent skin irritation, consult a physician.

Eye contact : Rinse thoroughly with plenty of water, also under the eyelids. In case of persistent eye irritation, consult a physician.

Ingestion : The product is not considered toxic based on studies on laboratory animals.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media : Water-soluble polymer in solution, water spray, foam, carbon dioxide (CO2), dry powder.

Special fire-fighting precautions : Aqueous solutions or powders that become wet render surfaces extremely slippery.

Protective equipment for firefighters : No special protective equipment required.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions : No special precautions required.

Environmental precautions : Do not contaminate water.

Methods for cleaning up : Do not flush with water. Clean up promptly by scoop or vacuum. Keep in suitable and closed containers for disposal. After cleaning, flush away traces with water

7. HANDLING AND STORAGE

Handling : Avoid contact with skin and eyes. Wash hands before breaks and at the end of workday.

Storage : Keep in a dry, cool place (0-35°C).

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal protection equipment

- *Respiratory protection :* No personal respiratory protective equipment normally required.
- *Hand protection :* Rubber gloves.
- *Eye protection :* Safety glasses with side-shields. Do not wear contact lenses.
- *Skin protection :* Chemical resistant apron or protective suit if splashing or contact with solution is likely.

Hygiene measures : Wash hands before breaks and at the end of workday. Handle in accordance with good industrial hygiene and safety practice

9. PHYSICAL AND CHEMICAL PROPERTIES

Form :	gel
Color :	clear - light yellow
Odor :	none
pH :	4 - 7 @ 5 g/l for product series. See Technical Bulletin for specific value.
Melting point (°C) :	Not applicable.
Flash point (°C) :	Not applicable.
Autoignition temperature (°C) :	Not applicable.
Vapour pressure (mm Hg) :	Not applicable.

Bulk density :	See Technical Bulletin
Water solubility :	See Technical Bulletin
Viscosity (mPa s) :	See Technical Bulletin

10. STABILITY AND REACTIVITY

Stability :	Product is stable. No hazardous polymerization will occur.. Oxidizing agents may cause exothermic reactions
Hazardous decomposition products :	Thermal decomposition may produce : nitrogen oxides (NOx), carbon oxides.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

- Oral :	LD50/oral/rat > 5000 mg/kg
- Dermal :	The results of testing on rabbits showed this material to be non-toxic even at high dose levels.

Irritation

- Skin :	The results of testing on rabbits showed this material to be non-irritating to the skin.
- Eyes :	May cause eye irritation with susceptible persons.
Sensitization :	The results of testing on guinea pigs showed this material to be non-sensitizing.
Chronic toxicity :	A two-year feeding study on rats did not reveal adverse health effects. A one-year feeding study on dogs did not reveal adverse health effects.

12. ECOLOGICAL INFORMATION

- Fish	LC50/Fathead minnows/96h > 1000 mg/l
- Algae :	EC50 / Selenastrum capricornutum / 96h > 500 mg/l
Bioaccumulation :	The product is not expected to bioaccumulate.
Persistence / degradability :	Not readily biodegradable.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products :	In accordance with federal, state and local regulations.

Contaminated packaging : Rinse empty containers with water and use the rinse water to prepare the working solution. Can be landfilled or incinerated, when in compliance with local regulations.

14. TRANSPORT INFORMATION

Not regulated by DOT.

15. REGULATORY INFORMATION

All components of this product are on the TSCA and DSL inventories.

RCRA status : Not a hazardous waste.

Hazardous waste number : Not applicable

Reportable quantity (40 CFR 302) : Not applicable

Threshold planning quantity (40 CFR 335) : Not applicable

California Proposition 65 Information : *The following statement is made in order to comply with the California Safe Drinking Water and Toxic Enforcement Act of 1986:* This product contains a chemical(s) known to the State of California to cause cancer: acrylamide

HMIS & NFPA Ratings		NFPA
Health :	1	1
Flammability :	0	0
Reactivity :	0	0
Personal Protection/Special :	B	

16. OTHER INFORMATION

Person to contact : Regulatory Affairs Manager

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MATERIAL SAFETY DATA SHEET
FERRIC CHLORIDE SOLUTION

KEMIRON PACIFIC, INC
14000 San Bernardino Ave.
Fontana, CA 92335
(909) 429 4001
(800) 527 7457

Emergency Phone Number:
(800) 527 7457

CHEMTREC
(800) 424 9300

NSF
Certified to ANSI/NSF 60

I. PRODUCT INFORMATION

Chemical Formula:	$FeCl_3$
Synonyms:	Ferric trichloride; ferric perchloride; iron perchloride; iron trichloride; iron (III) chloride; flores martis.
Molecular Weight:	162.21
CAS No.:	7705-08-0
NIOSH RTECS No.:	LJ9100000
Chemical Family:	Iron Salts

II. PHYSICAL PROPERTIES

Boiling Point:	225°F
Freezing Point:	10°F at 40% $FeCl_3$ (concentration dependent)
Specific Gravity (H_2O):	1.37-1.46
Vapor Pressure (mmHg):	No Data
Solubility in H_2O:	Completely Soluble
Evaporation Rate (Butyl Acetate = 1):	No Data
Flashpoint:	Not Applicable
pH (apparent):	< 1
pH (1% solution):	1.82
Appearance:	Dark reddish-brown color with an oily texture
Odor:	Slight, mild odor

III. INGREDIENTS

Components	CAS#	%	ACGIH TLV Exposure Limit
Ferric Chloride ($FeCl_3$)	7705-08-0	35-45	1 mg/m^3
Hydrochloric Acid (HCl)	7647-01-0	<0.50	5 ppm
Water	7732-18-5	55-65	None established

IV. HEALTH HAZARD INFORMATION

A. **Toxicity:**
orl-mus LD_{50}: 895 mg/kg
ivn-mus LD_{50}: 58 mg/kg
ipr-mus LD_{50}: 260 mg/kg
Mutagenic Data Cited
orl-rat LDLo: 900 mg/kg
ivn-rat TDLo: 2580 mg/kg
ivg-rat TDLo: 29 mg/kg

B. **Carcinogenicity:** Not listed as a carcinogen by NTP, IARC, OSHA, ACGIH, or NIOSH.

C. **Primary Route(s) of Entry:** Skin contact, ingestion

D. **Exposure/Health Effects:**

1. **Inhalation** – Minimal risk due to low vapor pressure. Product mists are irritating to mucous membranes, respiratory tract, and lung tissues. Altered respiratory rates may occur.
2. **Ingestion** – Low toxicity in small quantities, but larger doses (30 mg/kg) may cause stomach irritation which results in nausea, vomiting, and diarrhea. Mucous membranes and the gastrointestinal tract may also be burned. Pink urine discoloration is a strong indicator of iron poisoning. Liver cirrhosis, fibrosis of the pancreas, coma, and death may follow.
3. **Skin** – Prolonged contact may cause irritation with an accompanying blistering and staining. Highly and instantaneously toxic when injected into the bloodstream.
4. **Eyes** – Very corrosive to the eyes. May cause burns or severe irritation to the mucous membrane lining of the inner surfaces of the eyelids.

E. **First Aid Measures**

1. **Inhalation** – Remove from affected area and give oxygen/artificial respiration if needed. Seek medical attention for any breathing problems.
2. **Ingestion** – If victim is conscious, have drink large quantities of water or milk to reduce concentration and neutralize acid. Do not induce vomiting. If victim is unconscious, do nothing and keep victim warm. Seek medical attention immediately.
3. **Skin** – Remove contaminated clothing. Thoroughly wash affected areas with plenty of soap and water. Flush skin with water for 15 minutes. If irritation persists, seek medical attention.

VII STORAGE AND HANDLING

Ferric chloride is very corrosive to stainless steel, mild steel, bronze, iron, aluminum, and concrete. No metal, except for titanium and rubber-lined metals, should come into contact with the material. Storage tanks may be rubber- or PVC-lined. In addition, various plastics (e.g. PE, PVC, CPVC, FRP, Teflon) can be safely used. Appropriate protective gear should be worn when handling the material.

VI. SHIPPING INFORMATION

DOT Shipping Name:	Ferric Chloride Solution
DOT Hazard Class:	Corrosive Material
DOT Category:	ORM-B
DOT Placard:	UN 2582
Packing Group:	II
Reportable Quantity (RQ), lb. (gal.):	1,000 (85)
HMIS:	Personal Protective Code – B (Safety glasses, rubber gloves)
NFPA Rating:	2 (Health) – 0 (Flammability) – 0 (Reactivity)
ERG #:	154

IX. ENVIRONMENTAL PROTECTION PROCEDURE

A. **Spill Response** – If possible, dike area of spill. Neutralize with lime, soda ash, or sodium bicarbonate. If the spill is equal to or in excess of the RQ (1,000 lbs or 85 gals), then the National Response Center (800 424 8802) and the appropriate state and local agencies must be immediately notified.

B. **Waste Disposal** – Remove waste to an approved landfill or waste disposal facility. The treatment, storage, transportation, and disposal of waste material must be conducted in compliance with all applicable federal, state, and local regulations.

Prepared by: Fred D. Sims, Jr.
Effective Date: 05 May 2000
Revisions:

The information presented in this Material Safety Data Sheet (MSDS) is subject to revisions and is not all-inclusive, but represented as the best information available to date. This information was drawn from recognized sources believed to be reliable. Kemiron makes no representation as to the comprehensiveness or

accuracy of the information. Consequently, Kemiron will not be responsible for damages of any kind resulting from the use of or reliance upon such information.

The product discussed is sold without warranty, expressed or implied, and upon condition that purchasers shall perform their own verification and testing to determine its suitability for a particular purpose.

This MSDS was prepared in accordance with OSHA's Hazard Communication Standard 29 CFR 1910.1200